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BIOLOGICAL EVALUATION OF GYPSY MOTH

At

HARPERS FERRY NATIONAL HISTORICAL PARK

2007

Prepared by

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October 2007

ABSTRACT

On September 26 and October 9, 2007, USDA Forest Service personnel conducted a gypsy moth egg mass survey at Harpers Ferry National Historical Park (HFNHP). The purposes of this survey were to determine gypsy moth population densities, assess the potential for defoliation and the need for treatment in 2008. Current populations are sufficient to cause heavy defoliation on 1615 acres. Treatment is recommended to prevent defoliation and possible tree mortality.

METHODS

Gypsy moth survey plots were randomly selected based upon available host trees (oak species), size of sample area and uniformity between egg mass counts. At each sample point, a 1/40th acre fixed radius plot was established. The plots consisted of a tally of all the new (2007) egg masses observed on the overstory trees, understory vegetation, ground litter and duff. The total number of egg masses observed for each plot was multiplied by 40 to determine the number of egg masses per acre. Egg mass lengths were measured at the plots to determine the overall "health" of the existing population and as a measure of egg mass fecundity.

RESULTS

The location of the survey plots are shown in Figures 1-4. The summarized results of the survey are presented in Tables 1-4. In brief, overall egg mass densities ranged from 0-19,040 and averaged 5406 egg masses per acre. Egg mass densities averaged 5313 per acre on Short Mountain, 4382 per acre on Maryland Heights, ~~6936~~ 2636 per acre on Loudon Heights and 30 egg masses per acre near Bolivar. Overall egg mass lengths tended to be moderate to large in size, ranging from 12-54 mm and averaging 32 mm. Egg mass lengths averaged 29 mm on Short Mountain, 30 mm on Maryland Heights and 35 mm on Maryland Heights.

DISCUSSION

The basic guidelines used to evaluate the risk of defoliation include: previous defoliation events; number of egg masses/acre; size and condition of the egg masses; available preferred food; and risk of larval blow-in following egg hatch. Potential defoliation is categorized as; light (30-50 percent); and heavy (51-100 percent). Defoliation less than 30 percent generally has little impact on trees and can not be detected through aerial surveys.

The survey results indicate that heavy defoliation is likely on Short Mountain, Maryland Heights and Loudon Heights and will encompass approximately 1615 acres (Figure 5).

This conclusion is further supported when egg density is used as a means of predicting defoliation. Moore and Jones (1987) found that estimating the mean fecundity would increase the precision of gypsy moth density estimates and that a linear relationship exists between egg mass length and fecundity. Further work by Liebhold et al., (1993) demonstrates that the product of the mean egg mass length (mm) and egg mass density provides a more precise means of estimating population densities and prediction defoliation. Using Liebhold's model, Figure 6, shows how this information can be used to correlate the predicted defoliation of an area. Accordingly, the estimated egg mass density of 6071 egg masses per acre (average egg mass density the eastern portion of Short Mountain) x 29 mm (average egg mass length the eastern portion of Short Mountain) translates to a projected defoliation level of about 83 percent (heavy defoliation). Because egg mass densities and the host type are not evenly distributed, actual defoliation will vary from tree to tree but will be predominately heavy throughout this area of HFNHP. Heavy defoliation is also predicted for Maryland Heights and Loudon Heights. No defoliation is expected around Bolivar.

Based on existing egg mass densities and the general size of egg masses, gypsy moth populations appear to be building and healthy throughout most areas surveyed at HFNHP. The average egg mass length is 32 mm. Egg masses larger than 25 mm typically indicate healthy populations with no obvious stress from either the gypsy moth nucleopolyhedrosis virus (NPV) or the *Entomophaga maimaiga* fungus, two of the primary natural control agents that often express themselves in declining or stressed populations. There was no evidence that either one of these entomopathogens had significant impacts at HFNHP in 2007. Although it is still possible that either the gypsy moth fungus or the NPV could cause the general collapse of the gypsy moth population next year, it is unlikely that populations will collapse prior to a significant defoliation event occurring in 2008.

Predicting the extent of tree mortality that would occur after one year's defoliation is difficult, however, a stand of trees that is not stressed by other agents during or immediately following a single heavy defoliation will likely pull through with only minor branch dieback and minimal mortality. Trees that are defoliated in excess of 50 percent normally refoliate the same growing season. Such events cause the trees to expend valuable energy reserves to refoliate, and consequently cause the trees' health to deteriorate. Depending on the condition of the trees at the time of defoliation, reduced growth, mast abortion, branch dieback or in some cases tree mortality, has occurred following a single year of heavy defoliation. Should subsequent defoliation occur the following year, the impact is compounded. Trees that receive light defoliation (<50 percent) are not likely to refoliate and there is probably no significant impact other than a reduction in growth, reduction of mast and possibly some minor branch dieback.

Trees at greater risk are those that are presently stressed from other factors, such as soil compaction from roads, sidewalks, parking lots, machinery and/or heavy foot travel; over maturity; drought; shock due to recent timber cutting activities; previous year(s) defoliation; and other insect and disease related problems. HFNHP experienced a prolonged and severe drought during the 2007 growing season. Also, 215 acres of heavy

defoliation were detected during the aerial survey conducted on June 11 (see defoliation survey report dated June 25).

The Allegheny National Forest (1988) and the West Virginia Division of Forestry (1997) provide examples of the potential tree mortality that can occur. On the Allegheny National Forest, untreated stands consisting of 40-80 percent oak, the average loss of basal area (mainly oaks) was about 16 percent (range 3-28 percent) following one year of defoliation and 26 percent (range 10-43 percent) after two consecutive years of defoliation. In a 1986 study area in eastern West Virginia where oak species accounted for 63-78 percent of the species composition, a loss of 25 percent of the total oak saw timber and 14 percent of the total oak pole timber occurred after one year of moderate to heavy defoliation. In these examples, droughty conditions likely contributed to the level of mortality.

Based on observations of the existing health of the forested areas at HFNHP and the factors mentioned above, large areas of extensive tree mortality are expected if defoliation occurs. Mortality will be more severe if adequate rainfall is not received during the 2008 growing season and/or if the defoliation occurs in areas that were defoliated in 2007.

Management Options

In 2008, two management options have been evaluated for managing gypsy moth populations at HFNHP. The intervention options are offered based upon the following two treatment objectives: 1) protect host tree foliage to prevent branch dieback and tree mortality; and 2) reduce gypsy moth population below the treatment threshold. Each is discussed below.

No Action Option

It is possible that gypsy moth populations could collapse on their own due to the presence of nucleopolyhedrosis virus (NPV) or the more recently recognized fungal pathogen, *Entomophaga maimaiga*. In areas with defoliating levels of gypsy moth populations, viral epizootics generally manifest themselves after significant tree defoliation has already occurred. Gypsy moth populations will usually peak in 2-3 years once they reach levels and then collapse as a result of NPV or fungal activity. Residual populations following such a collapse will likely remain at low densities for 3-6 years before rebuilding to defoliating levels.

Although it is not possible to accurately assess such events with the defoliating levels and then collapse as a result of NPV or fungal activity. Residual populations information at hand, it is unlikely that a collapse will occur in 2008 since most of these areas are newly infested and there is an abundance of large healthy egg masses.

Large numbers of gypsy moth caterpillars and defoliation has been shown to impact competing native herbivore arthropods. Sample et al., (1996) showed short-term impacts of both species richness and abundance occurred following light to moderate defoliation events in study plots in West Virginia. It is likely that impacts would be greater as the size

of the area and intensity of defoliation increases and be more long term, should extensive tree mortality occur.

Should this option be selected, it is likely wide spread defoliation will occur at HFNHP in 2008.

Microbial Insecticide Option

***Btk*:** The only biological insecticide currently registered and commercially available for gypsy moth control is the microbial insecticide *Bacillus thuringienis* variety *kurstaki (Btk)*. This insecticide is available through several manufacturers and has been used extensively in suppression projects throughout the U.S. in both forested and residential areas. *Btk* is a bacterium that acts specifically against lepidopterous larvae as a stomach poison and therefore must be ingested. The major mode of action is by mid-gut paralysis which occurs soon after feeding. This results in a cessation of feeding, and death by starvation. *Btk* is persistent on foliage for about 7-10 days.

Btk has been shown to impact other non-target caterpillars that are actively feeding at the time of treatment. An example of the potential impacts is provided by a study conducted by Miller (1990) in Oregon and Samples, et al., (1996) in West Virginia. Miller's study involved a large scale (5,000 acres) eradication program where three consecutive applications of *Btk* were applied within a single season. On Garry oak, Miller found that species richness was significantly reduced in treated areas during all 3 years of the study while the total number of immature native Lepidoptera rebounded after the second year. In the Sample study, the areas treated with *Btk* were 50 acre plots and only a single treatment applied. Here too, both species richness and the total numbers of native macro-lepidopterous caterpillars and adults were reduced but only for less than 1 year. The difference in duration of the impacts between these studies is probably the result of the number of treatment applications applied and the size of the treatment area involved.

Btk formulations are available as flowable concentrates, wettable powders, and emulsifiable suspensions. The normal application rates range from 24-36 billion international units (BIUs) per acre in a single or double application. *Btk* can be applied either undiluted or mixed with water for a total volume of ½ -1 gallon per acre. With proper application, foliage protection and some degree of population reduction can be expected with one application and with two applications both foliage protection and a greater degree of population reduction are likely.

Because *Btk* is a biological insecticide, the degree of population reduction varies and may depend on, at least in part, the selected application rate, relative health of the population (building vs. declining), population densities, weather (rain and temperature), the feeding activity of the larvae following treatment, and the actual potency of the product.

Gypchek: A second microbial insecticide that is registered and available in limited quantities is the formulated nucleopolyhedrosis virus called Gypchek. This product is not available commercially but is produced in limited quantities by a cooperative effort of the USDA Forest Service and the Animal Plant Health Inspection Service (APHIS). The

active ingredient in Gypchek formulations has a very narrow host range (lymnatriids) and occurs naturally in gypsy moth populations. Normally the virus reaches epizootic proportions when gypsy moth populations reach high densities as a result of increased transmission within and between gypsy moth generations. The application of Gypchek to gypsy moth populations simply expedites this process by increasing the exposure of the virus at an earlier stage. Healthy, feeding gypsy moth caterpillars become infected by ingesting contaminated foliage and soon stop feeding and die.

The efficacy of Gypchek treatments to reduce gypsy moth populations has been quite variable. Because of the short period of viral activity on foliage (3-5 days) as well as other biological factors such as feeding activity and weather conditions, it has been difficult at best to project treatment efficacy. Most often foliage protection can be achieved but significant reductions in gypsy moth densities do not always occur. Should inadequate population reduction occur, areas would need to be treated again the following year.

The normal application rate of Gypchek is 4×10^{11} occlusion bodies (OB's) per acre applied in a single application or 2×10^{11} OB's per acre applied in a double application. Due to the limited supply, priority is first given to state and federal cooperators that need to deal with federally listed threatened and endangered species associated with gypsy moth treatments. There are, however, sufficient quantities of Gypchek currently available for 2008 should this insecticide be preferred for use at HFNHP.

Alternatives

With the previously described options in mind, the following alternatives are offered:

Alternative 1. - No action.

Alternative 2. - One aerial application of *Btk* at the rate of 36 BIUs in a total mix of ¾ gallon per acre.

Alternative 3. - Two aerial applications of *Btk*, as in alternative 2, applied 4-7 days apart.

Alternative 4. - One aerial application of Gypchek at the rate of 4×10^{11} OB's in a total mix of 1 gallon per acre.

Alternative 5. - Two aerial applications of Gypchek at the rate of 2×10^{11} OB's in a total mix of 1 gallon per acre, applied 3-5 days apart.

RECOMMENDATIONS

As previously stated, gypsy moth populations at HFNHP are healthy, building and sufficient to cause 1615 acres of heavy defoliation in 2008. To protect tree foliage and prevent subsequent tree mortality, our recommendation is alternative 3 (a double application of *Btk*).

This recommendation is based on the following considerations:

1) Based on the health and high gypsy moth population levels, a single application of *Btk* is not likely provide either foliage protection or a significant egg mass reduction.

2) A double application of *Btk* is likely to provide both foliage protection and a significant population reduction.

3) Gypchek is less likely to provide adequate foliage protection or a significant population reduction than *Btk* .

4) There are no known threatened or endangered lepidopteron in the treatment areas.

REFERENCES

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Gottschalk, K.W. 1990. Gypsy moth impacts on mast production, *In*: McGee, Charles E. Ed. Proceedings of the Workshop, southern Appalachian Mast Management; 1989 August 14-16; Knoxville TN; University of Tennessee; 42-50.

Liebhold, A.M., Simons, E.E., Sior, A., and Unger, J.D. 1993. Forecasting defoliation caused by the gypsy moth from field measurements. Environ. Entomol. 22(1): 26-32.

Miller, J.C. 1990. Field assessment of the effects of a microbial pest control agent on non-target Lepidoptera. American Entomologist 36:2, 135-139.

Moore, K.E.B. and Jones, C.G. 1987. Field estimation of fecundity of gypsy moth (Lepidoptera: Lymnatriidae). Environ, Entomol. 16: 165-167.

Sample, B.E., Butler, L., Zivkovich, C., Whitmore, R.C., and Reardon, R.C. 1996. Effects of *Bacillus thuringiensis* Berliner var. *Kurstaki* and defoliation by gypsy moth [*Lymantria dispar* (L.) (Lepidoptera: lymnatriidae)] on native arthropods in West Virginia. The Canadian Entomologist 128:573-592.

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Table 1. – Results of the gypsy moth egg survey results at Short Mountain (Harpers Ferry NHP), September 26, 2007

Plot #	#em/acre	Average em length (mm)
1	0	—
2	0	—
3*	960	28
4*	720	24
5*	4840	29
6*	6640	37
7*	1160	39
8*	1440	32
9*	12,320	34
10*	7320	26
11*	12,400	24
12*	19,040	29
13*	11,160	31
14*	600	21
15*	5520	28
16*	880	20

em/ac range = 0-19,040
em/ac average = 5313

em size range (mm) = 12-54
em size average (mm) = 29

* = located in proposed treatment block

em/acre range in proposed treatment block = 0-19,040

em size range (mm) in proposed treatment block = 12-54

em/ac average in proposed treatment block = 6071

em size average (mm) in proposed treatment block = 29

Table 2. – Results of the gypsy moth egg survey results at Maryland Heights (Harpers Ferry NHP), September 26, 2007

Plot #	#em/acre	Average em length (mm)
1	0	—
2	0	—
3*	0	—
4*	720	—
5*	9720	27
6*	15,160	32
7*	280	19
8*	9120	22
9*	12,160	38
10*	4480	31
11*	3320	35
12*	4760	29
13*	3800	37
14*	5840	35
15*	1960	31
16*	3120	29
17*	3440	27
18*	1000	27

em/ac range = 0-15,160
em/ac average = 4382

em size range (mm) = 16-48
em size average (mm) = 30

* = located in proposed treatment block

em/acre range in proposed treatment block = 0-15,160

em size range (mm) in proposed treatment block = 16-48

em/ac average in proposed treatment block = 4930

em size average (mm) in proposed treatment block = 30

Table 3. – Results of the gypsy moth egg survey results at Loudon Heights (Harpers Ferry NHP), October 9, 2007

Plot #	#em/acre	Average em length (mm)
1*	560	30
2*	640	41
3*	3080	38
4*	11,120	31
5*	9240	31
6*	8720	31
7*	4040	37
8*	3240	33
9*	3120	29
10*	1960	26
11*	11,480	37
12*	1160	37
13*	1560	32
14	0	—
15	80	—
16	0	—
17*	560	34
18*	9680	36
19*	2080	43
20*	1480	42
21*	1400	35
22*	3720	34
23*	5880	41
24	0	—
25*	120	46
26*	240	32
27*	2120	31

em/ac range = 0-11,480
em/ac average = ~~5936~~ 3232

em size range (mm) = 18-52
em size average (mm) = 35

* = located in proposed treatment block

em/acre range in proposed treatment block = 120-11,480

em size range (mm) in proposed treatment block = 18-52

em/ac average in proposed treatment block = ~~6933~~ 3791

em size average (mm) in proposed treatment block = 35

Table 4. – Results of the gypsy moth egg survey results near Bolivar (Harpers Ferry NHP), September 26, 2007

Plot #	#em/acre	Average em length (mm)
1	40	—
2	80	—
3	0	—
4	0	—

em/acre range = 0-80
em/average = 30

Figure 1. -- Gypsy moth egg mass survey plot locations on Short Mountain, September 26, 2007.

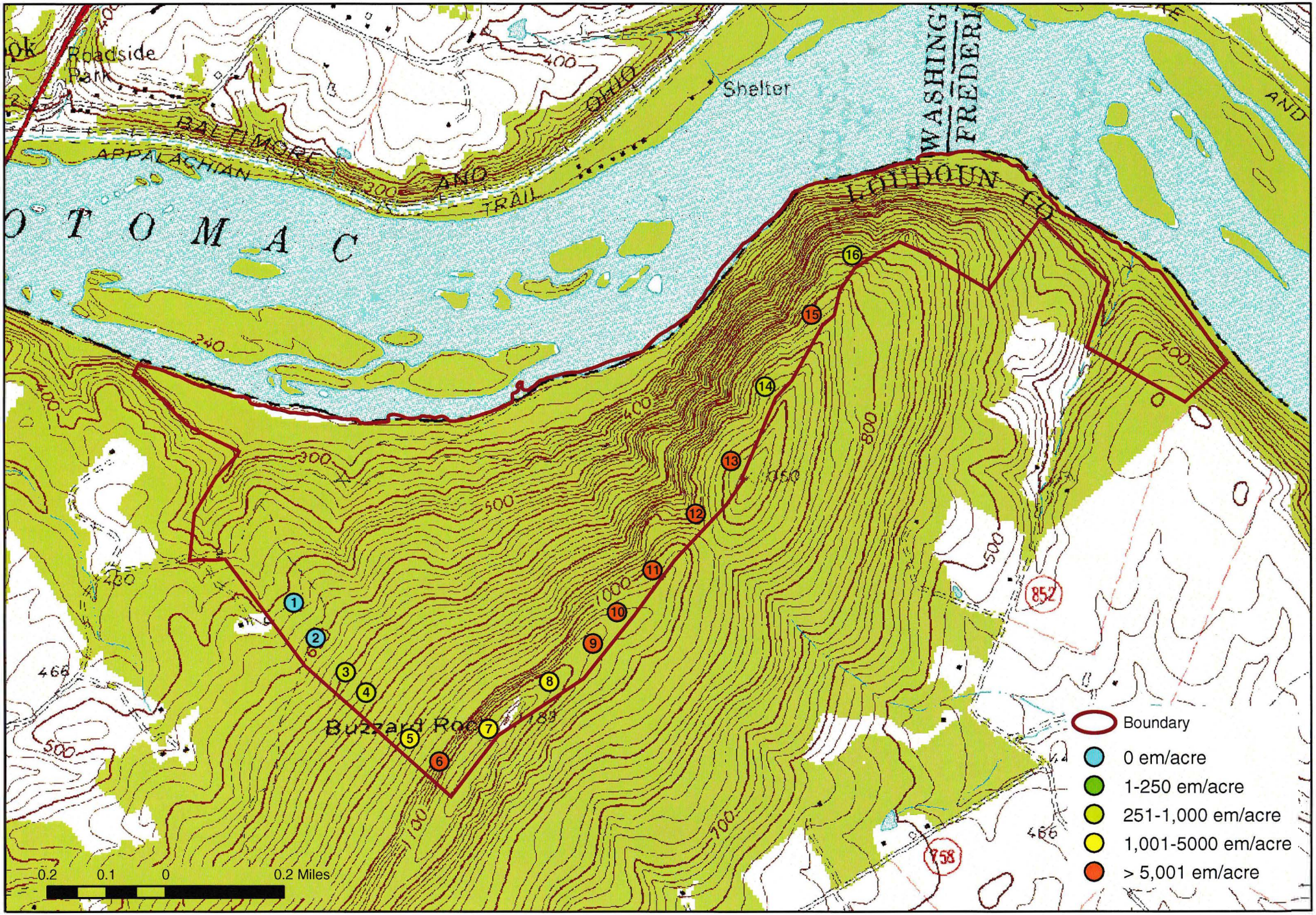


Figure 2. -- Gypsy moth egg mass survey plot locations on Maryland Heights, September 26, 2007.

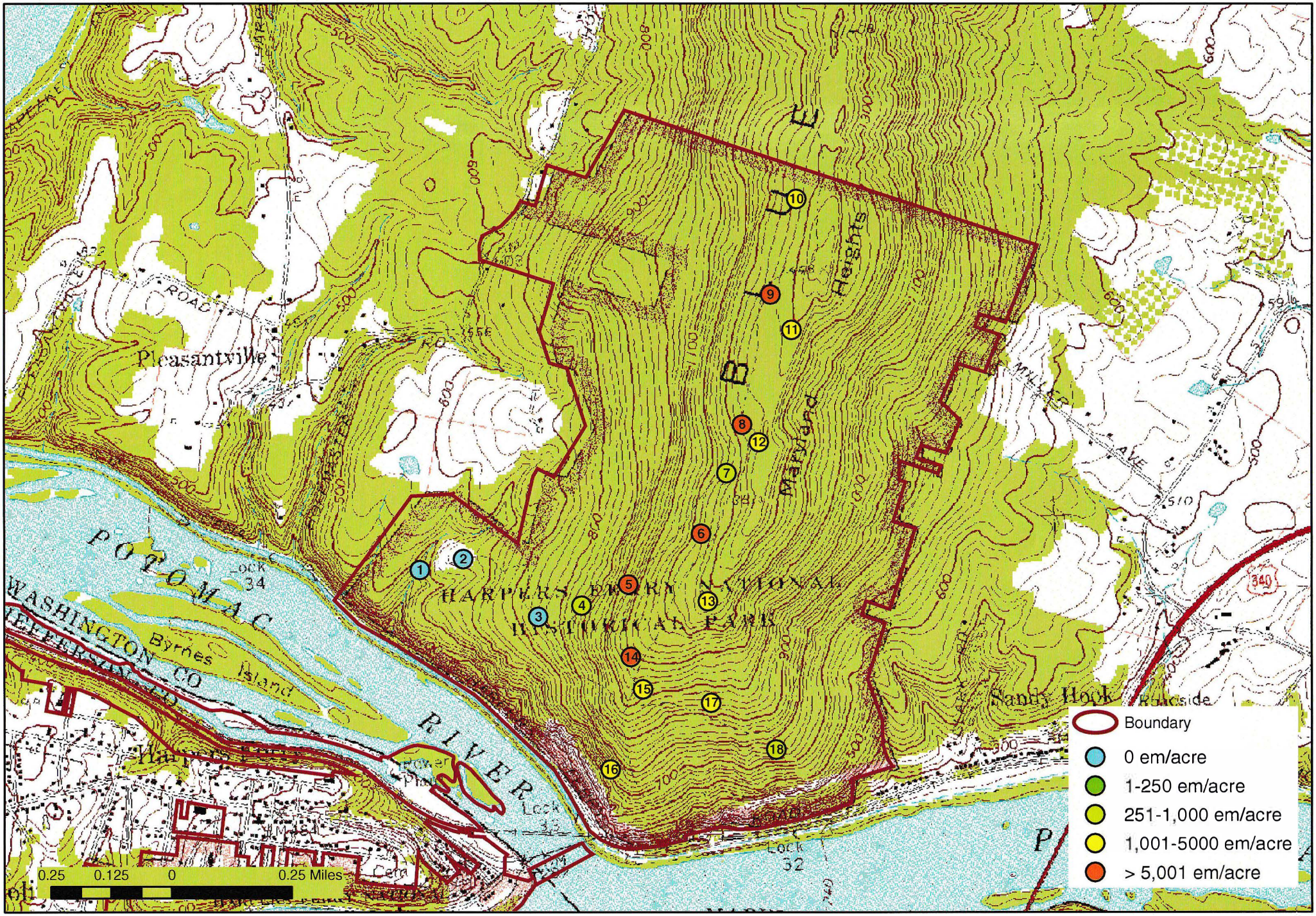


Figure 3 -- Gypsy moth egg mass survey plot locations on Loudon Heights, October 9, 2007.

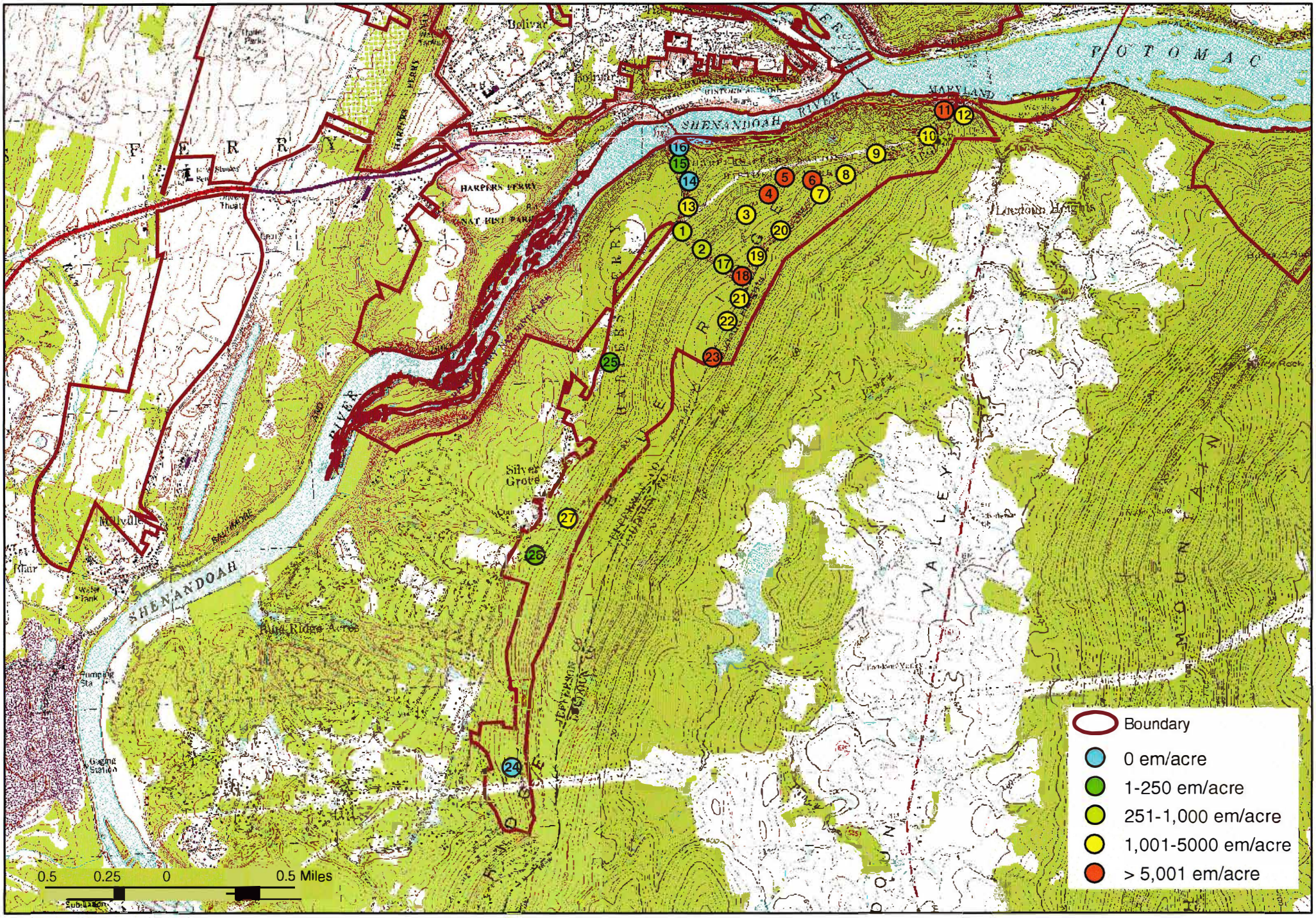


Figure 4. -- Gypsy moth egg mass survey plot locations around Bolivar, September 26, 2007.

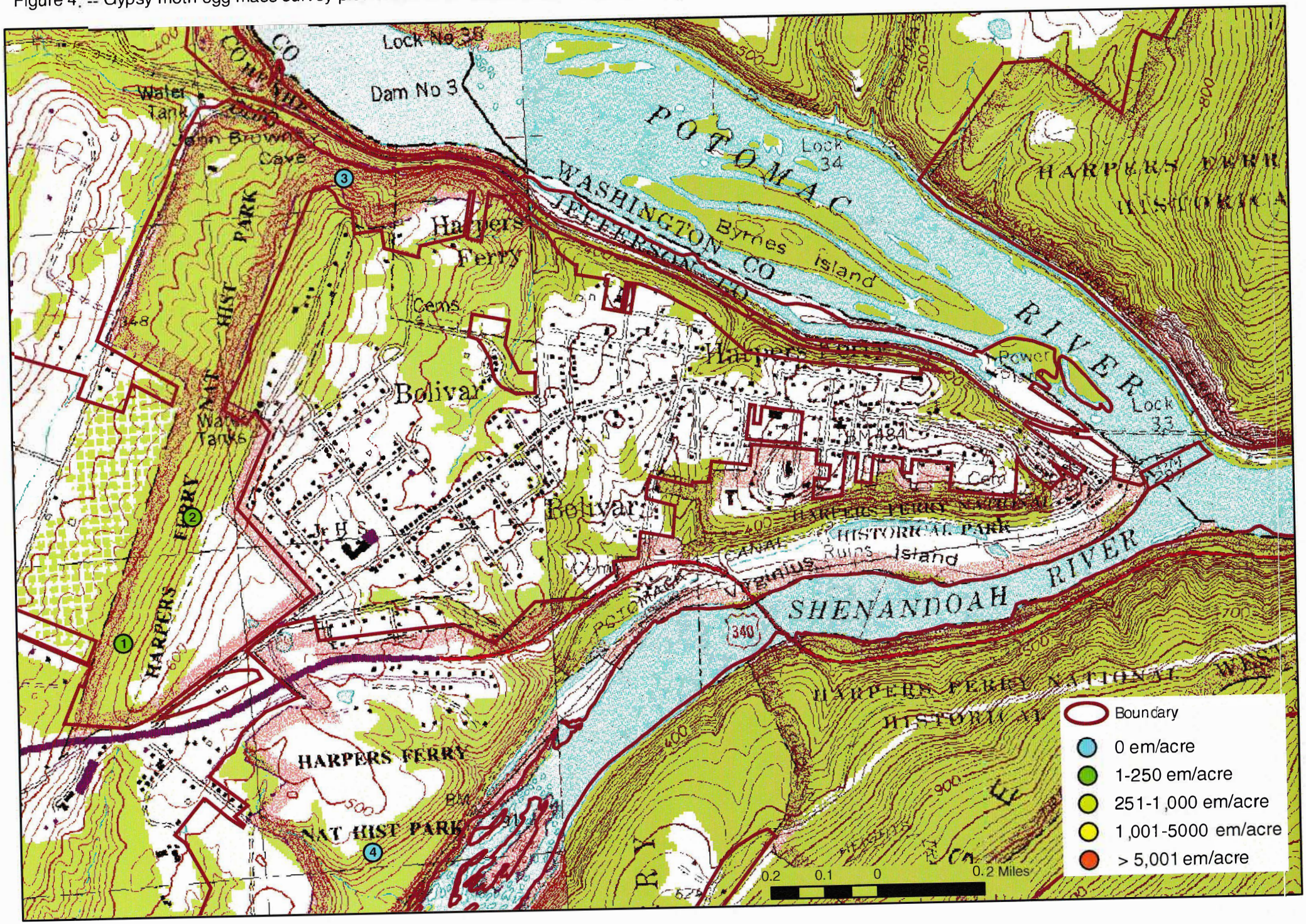
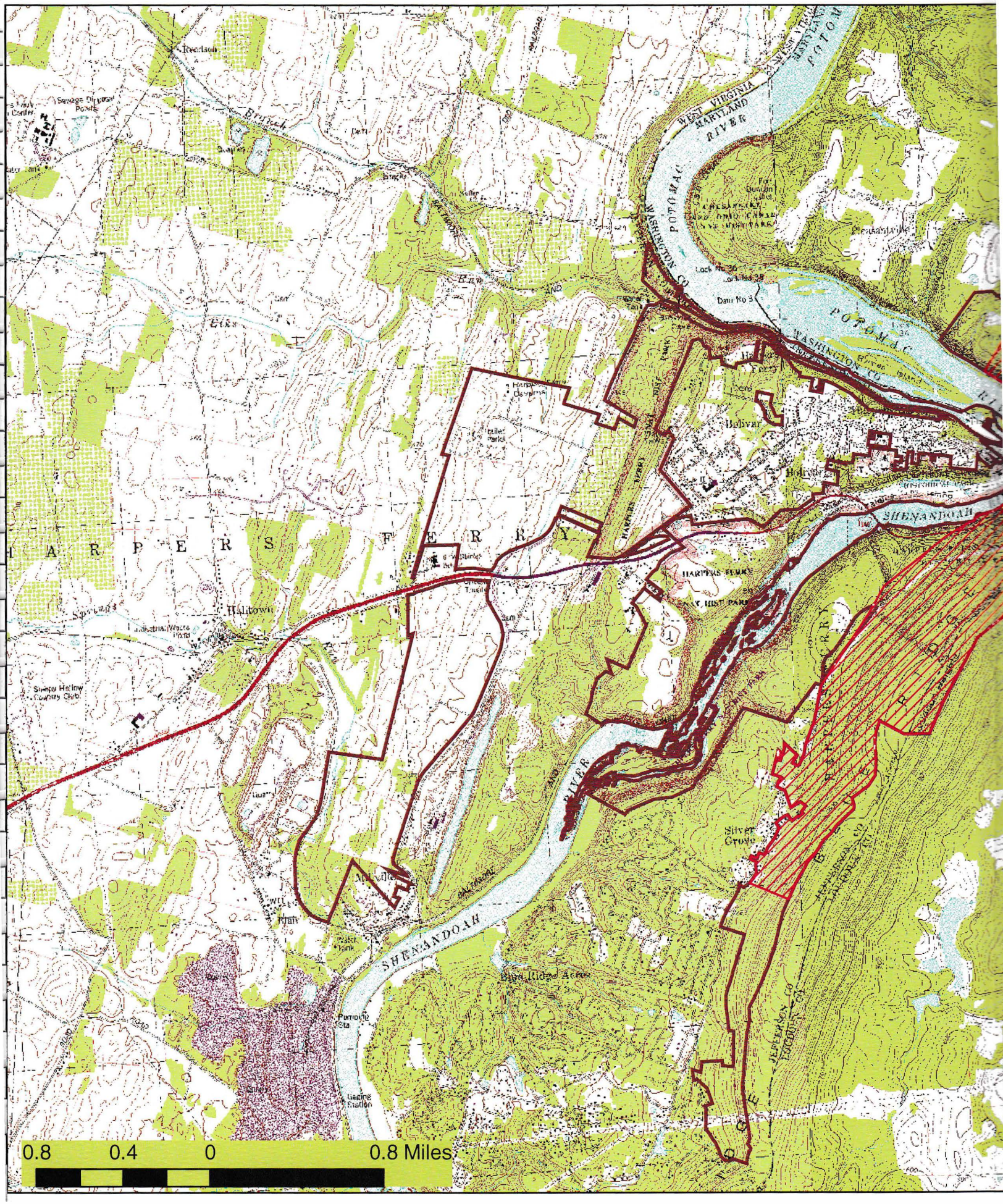


Figure 5. -- Areas where defoliation is likely in 2008/Recommended treatment areas



reas.

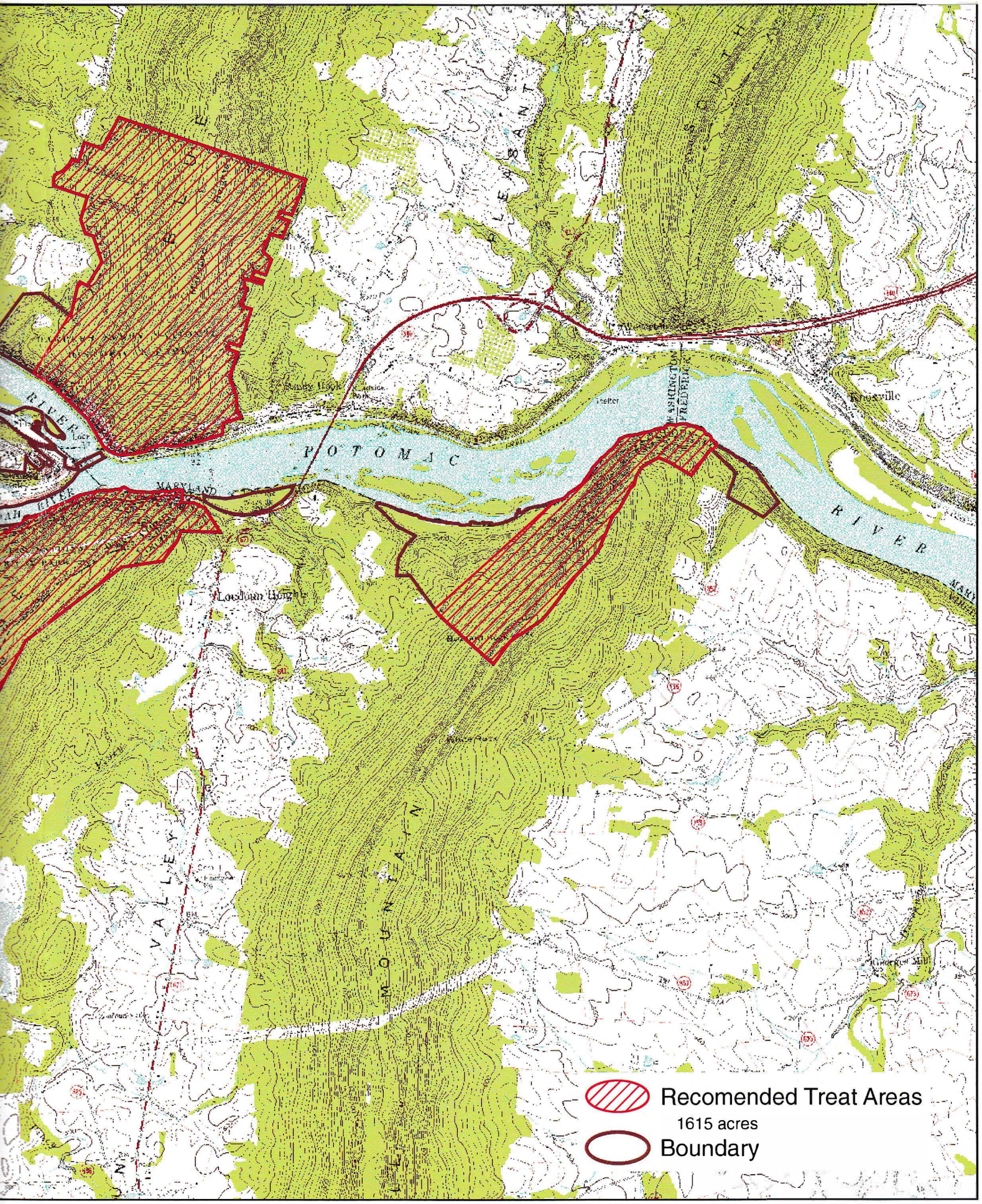
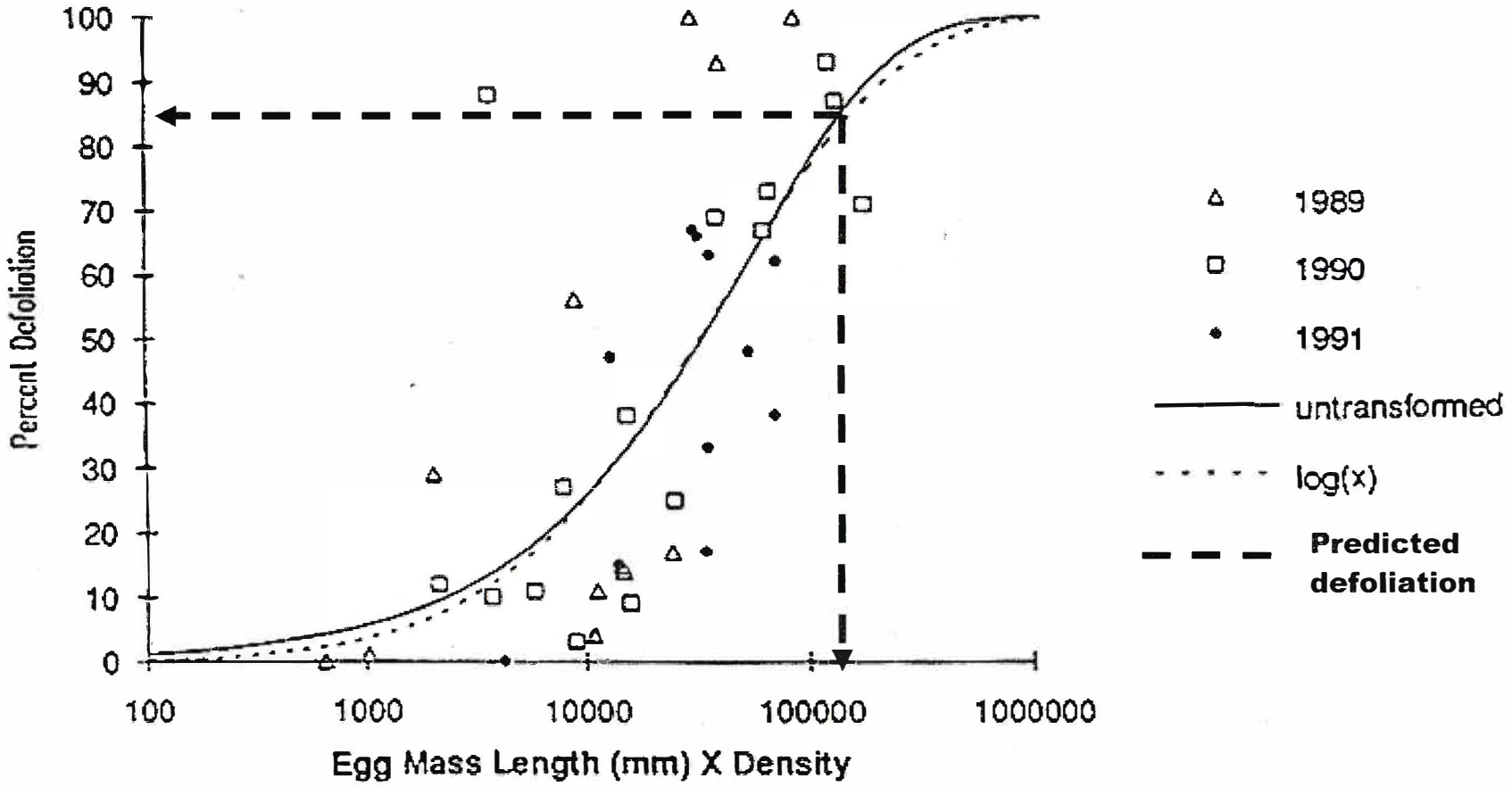

POTOMAC
RIVER
MARYLAND
Loudoun Heights
VALLEY
MOUNTAIN
Recomended Treat Areas
1615 acres
Boundary

Figure 6.—Predicted defoliation in the eastern portion of Short Hill at HFNHP in 2008.



Scatter plot of the product of mean egg mass length and egg mass density versus mean defoliation. Extracted from Liebhold et al. (1993).

USDA United States Department of Agriculture | Forest Service | Northeastern Area State and Private Forestry | 180 Canfield Street Morgantown, WV 26505-3101

File Code: 3410
Date: October 18, 2007

Mr. Donald Campbell, Superintendent
Harpers Ferry National Historical Park
USDI National Park Service
PO Box 65
Harpers Ferry, WV 25425

Dear Mr. Campbell:

Enclosed is the gypsy moth biological evaluation for Harpers Ferry National Historical Park.

In brief, gypsy moth populations are sufficient to cause heavy defoliation on Short Mountain, Maryland Heights and Loudon Heights. We are recommending a double application of *Bacillus thuringienis* variety *kurstaki (Btk)* on 1615 acres. With good timing and proper application, gypsy moth defoliation should be minimal at Harpers Ferry National Historical Park in 2008.

Please contact me at 304-285-1555 if you have any questions regarding this gypsy moth biological evaluation.

Sincerely,

Rodney L. Whiteman

RODNEY L. WHITEMAN
Forester
Forest Health Protection

Enclosure

Cc: Bill Hebb, HFNHP
Jil Swearingen, CUE
Robert Tichenor, MDA
Thomas Lupp, MDA
Butch Sayers, WVDA
Robert Lueckel, MFO
Noel Schneeberger, AO